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Project Title: Establishment of Effective Natural Enemies of Vine Mealybug: A Basis for a Stable Grape IPM Program

Summary:

A total of more than 230,000 mealybug parasites from 4 species were released from February through October in 1997. Parasites were from 6 colonies of *Anagyrus pseudococci* from different geographical sources, one colony of *Leptomastidea abnormus,* one colony of *Coccidoxenoides peregrinus,* and a new species of *Anagyrus.*

In caged evaluations of the nine parasite colonies, from February through October, one colony of *Anagyrus* was significantly superior to all others tested. The *Anagyrus* from Coachella was the least effective of *Anagyrus* tested more than 7 times in 3 fields. Two other colonies of *Anagyrus* also provided exceptionally promising results. Both of these have been assessed only for 1 year and require a minimum of 1 more season of evaluations.

Uncaged trap plants were also placed in the same 3 fields from February through October. In results from these trials, we found highly significant differences in numbers of parasites recovered from release versus non-release areas of the same fields. The greatest differences were from the hottest area sampled where approximately 2,000 times more parasites were recovered in release versus non-release areas.

In both caged and open field trials, positive results were obtained throughout the test period. This indicates that all parasites tested survive, find, and parasitize mealybugs through winter, spring, and hot summer conditions.

Ant control was evaluated by using ant bait around areas where parasites were being evaluated. Plants surrounded by bait were seldom infested with ants; whereas, plants without bait were severely infested with ants tending and guarding the mealybugs. These preliminary findings indicate a strong need to combine ant control with parasite release to enhance effectiveness of the latter.

A Grape IPM Innovator Program has been established in which parasite releases and ant control will be assessed as an alternative treatment to use of insecticides. We plan to assess the 2 treatments (IPM versus insecticides) by comparing fruit yield and quality at harvest and by conducting evaluations of the releases.

RESULTS and DISCUSSION

Objective 1: Import, rear, release parasites, and determine their status for the following year.

In 1997, nine parasite populations were mass reared and released in the Coachella Valley. Of these nine, the three best *Anagyrus* colonies were carried over from the 10 *Anagyrus* colonies reared and evaluated in 1996. These three were from Algeciras, Spain; Givat Ada and Arugot, Israel. Three other colonies imported late in 1996 were not released from quarantine in time for 1996 rearing and evaluations. These were also included in the 1997 rearings and evaluations: San Martín, Spain (combined with Algeciras because of their proximity in Spain); Cabasuelas and Monteforte, Spain (Table 1). The *Leptomastidea* and *Coccidoxenoides* colonies were released from quarantine too late in 1996 for mass rearing and evaluations. They were also included in the 1997 trials. Two additional colonies were obtained in February, 1997, from hot, grape areas in Argentina: one *A. pseudococcae* and one *Leptomastidea abnormus*. The *Anagyrus* was released from quarantine in time for some trials in 1997, but the release of *Leptomastidea* was delayed too long to effectively mass rear and evaluate it in 1997. A total of more than 230,000 parasites were released in the Coachella Valley in 1997 (Table 1). In release areas we recovered all species released. Differences in parasites recovered from the three fields reflect in part significant differences in parasites released in each field (Table 1). The greater numbers of parasites were recovered from fields having greater numbers of parasite releases. This indicates that parasites are surviving and increasing in numbers as the season progresses.

Parasites were recovered from pre-release samples in February, indicating establishment from releases in 1996.

Objective 2: Screen native biological control agents and compare their effectiveness in the field with introduced species and/or biotypes.

In evaluating native and introduced parasites, we placed mealybugs in field cages in each of the 3 fields under the vine canopy in areas where there were no parasite releases. We also placed mealybugs in uncaged, trap-plantings, also under vine canopies in each of the 3 fields, but in 2 areas: (1) parasites released and (2) no parasites released.

Results of cage trials from 3 fields during February through October are summarized in Figures 1, 4-9. The data summarized in Figure 1 are based on data from 3 fields in which releases were made at various dates from February through October. However, there was considerable variation in the results, from field to field and between dates. This variation can be seen in Figures 4-9. Despite the variation in all fields, from all release dates, the *Anagyrus* from Arugot, Israel, consistently provided the best results in finding and parasitizing mealybugs. These results are particularly important in the spring and early summer when mealybugs are building up. Four other *Anagyrus* colonies and the one *Leptomastidea* were all more effective than the native *Anagyrus* from the Coachella Valley. *Coccidoxenoides* were the least effective of all parasites tested.

From the 3 fields, the data from the Organic farm provides the most complete results because insecticides were not used at any time on that farm. In the other 2 farms, Sun World and Peter Rabbit, insecticides were used all around our release sites beginning in early spring and continuing throughout the season. From the Organic farm data (Figs. 4 and 6) 3 colonies of

Anagyrus look much better than the others (expect perhaps Algeciras, already released from 2 years). These 3 promising colonies are Arugot, Argentina, and Estacion de Blanca. Data from the other 2 farms (Figs. 5, 7-9) at various dates also provide evidence of promising potential from Arugot, Estacion de Blanca and *Leptomastidea*. Parasites from Argentina were only released in large numbers in the Organic farm, thus data on this parasite are incomplete from Sun World and Peter Rabbit farms.

In results from uncaged trap-plantings containing vine mealybugs we recovered significantly greater numbers of all parasites from release areas than from non-release areas in all 3 fields (Figures 2 and 3). Significant differences were also found in parasites recovered from release areas among the 3 fields. Differences between fields may in part be caused by a significant temperature gradient in the Coachella Valley in which fields on the eastern portion have higher temperatures over a longer time during the day than do fields on the western side of the valley. Our fields are on both eastern and western edges of the valley. As noted under objective 1, more parasites were recovered in fields where more parasites were released.

Objective 3: Obtain information on ant species, test control methods to eliminate or reduce ant numbers without disturbing natural enemies.

Two species of ants found tending and guarding vine mealybugs in the Coachella Valley have been collected and identified. These are *Formica perplinosa* and California fire ants (*Solenopsis* sp.). We need additional studies to determine which one or if both of these species (or other species) are most important in protecting mealybugs.

Max-force ant bait was assessed preliminarily in both caged and uncaged trials with plants containing mealybugs. In most cases, in plants surrounded by ant bait, ants were not a problem in disrupting mealybug/parasite interactions. When ant bait was not used, plants were severely infested with ants guarding and tending the mealybugs. Although our results are preliminary, we believe that ant control is essential for enhancing parasite effectiveness against mealybugs. This needs to be further evaluated in our trials to determine the most effective application and dosage methodology for reducing ant interference.

Our plans for 1998 are to use Max Force ant bait on the platforms where the parasites are placed in cages for weekly evaluations. Ant bait will be placed surrounding the platforms on alternate weeks. In weeks without ant bait, we will collect, count, and identify all ants on each cage and platform. Mealybugs remaining in cages will be held in the laboratory for parasite emergence. Assessment of ant impact on parasites will be based on analyses of variance from treatments (a) bait (b) no bait, for each parasite colony, for numbers of parasites emerging. Correlations and regression analyses will be used to relate numbers of ants versus numbers of parasites emerging.

Objective 4: To establish an IPM Innovator Program

Several meetings were held with growers concerning the formation of an IPM Innovator Program in the Coachella Valley. At their suggestion, the last meeting was held in late September 1997, at which time we encouraged more widespread involvement and a firm commitment for active participation. At the September meeting, a representative of Corona Foothill Insectary participated in the meeting to explore the feasibility of growers actively becoming involved in commercial releases of parasites evaluated by us. We believe that releases of effective parasites, ant control, and washing of fruit at harvest will provide a viable alternative

to insecticide applications. We have proposed establishing trials in which we will compare our program with that of the current insecticide usage on each farm that becomes actively involved. We will access fruit yield and quality at harvest as the main criteria for evaluating our program.

An active IPM Innovator Program was formed with David Fenn from Sun World International, as the Chair of the Coachella Valley IPM Program for grapes. Through this program, our efforts to mass release effective parasites will be coordinated with resources from a commercial insectary and with results on ant control through Harry Shorey. The program also will provide a basis for requesting funds from agencies whose goal is to reduce pesticide use and increase cost-effective biological control. Requests for funds to support a pilot program of large scale mass release of parasites has been made by the commercial insectary noted above to the State of California (Cal EPA) and to other agencies.

Table 1

Total Parasite Releases Per Colony
2/13/97 Through 10/10/97

Species	Origin	Crop	S&R #	Room	Total Released
Anagyrus pseudococci	Algeciras;San Martin, Spain	Citrus	95-46	D-3	32200
Leptomastidea abnormis	Jordan Valley, Israel	Citrus & Pomegranate	95-71#5	D-4	39955
Anagyrus pseudococci	Arugot, Israel	Grapes	95-71#1	G-4	25100
Anagyrus pseudococci	Estacion de Blanca & Cabasuelas, Spain	Grapes	96-36	G-5	70808
Anagyrus pseudococci ?	Argentina	Grapes	97-03#1-6	H-2	12450
Anagyrus pseudococci	Monteforte, Spain	Grapes	96-35 & 96-36	H-4	6950
Anagyrus pseudococci	Coachella Valley, CA		N/A	AG/OPS	2000
Anagyrus pseudococci	Givat Ada, Israel	Grapes	95-69#2,3,4	I-1	23860
Coccidoxenoides peregrinus	Israel	Citrus & Grapes	95-69,70,71	AG/OPS	4120
Anagyrus pseudococci	Kfar Tabor, Israel	Figs	95-72		6600
Anagyrus pseudococci	Estacion de Blanca, Spain	Grapes	96-36		4400
Anagyrus pseudococci	Cabasuelas Murcia, Spain		96-36		2400
				Total	**230843**

	Organic Field	Peter Rabbit	Sun World
A. pseudococci	122710	22750	41308
L. abnormis	30800	2130	7025
C. peregrinus	1170	1080	1870
Total	154680	25960	50203

Figure 1

ANAGYRUS PSEUDOCOCCI (except where noted otherwise)

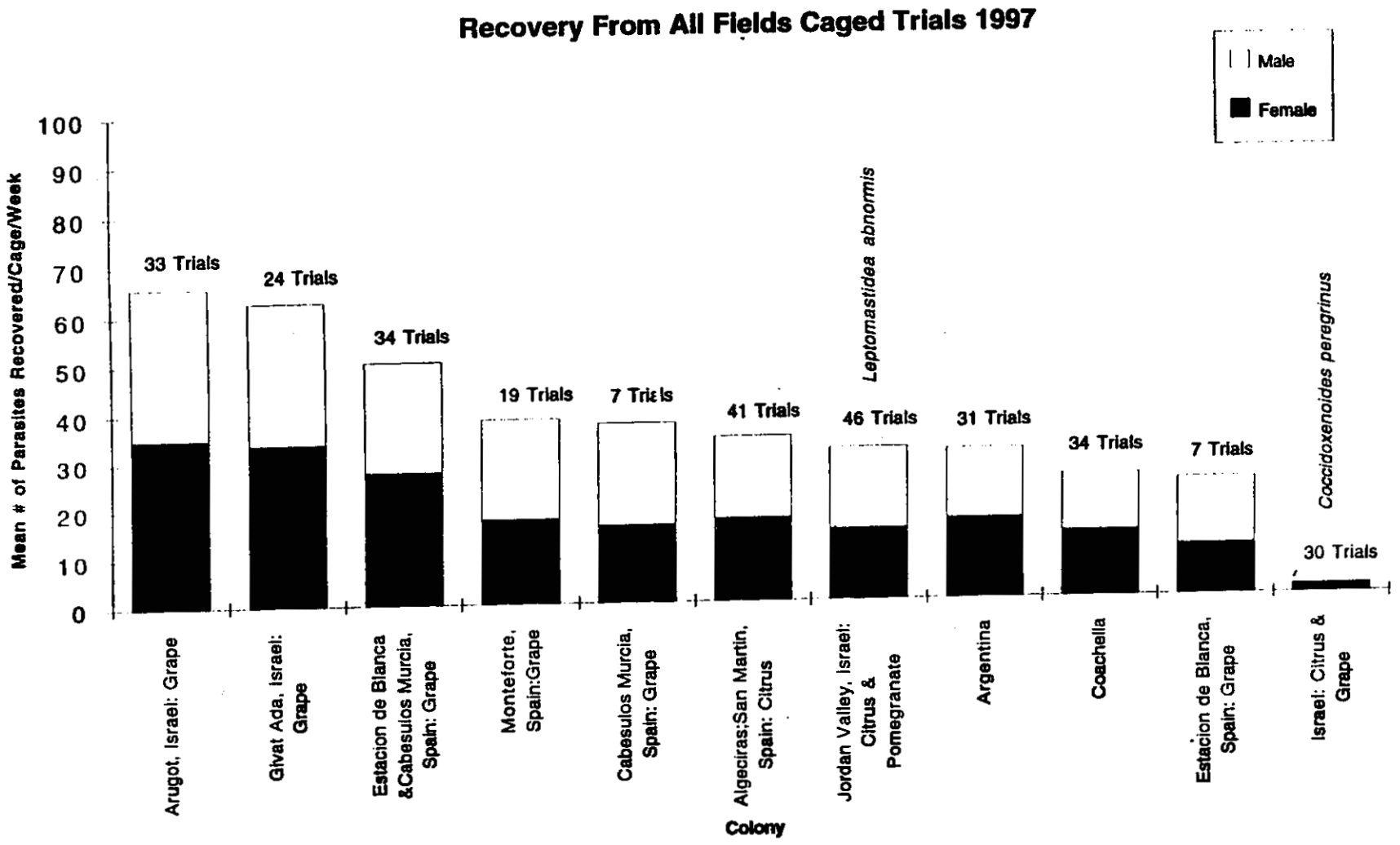


Figure 2

Parasites Recovered in Open Cage Trials 1997

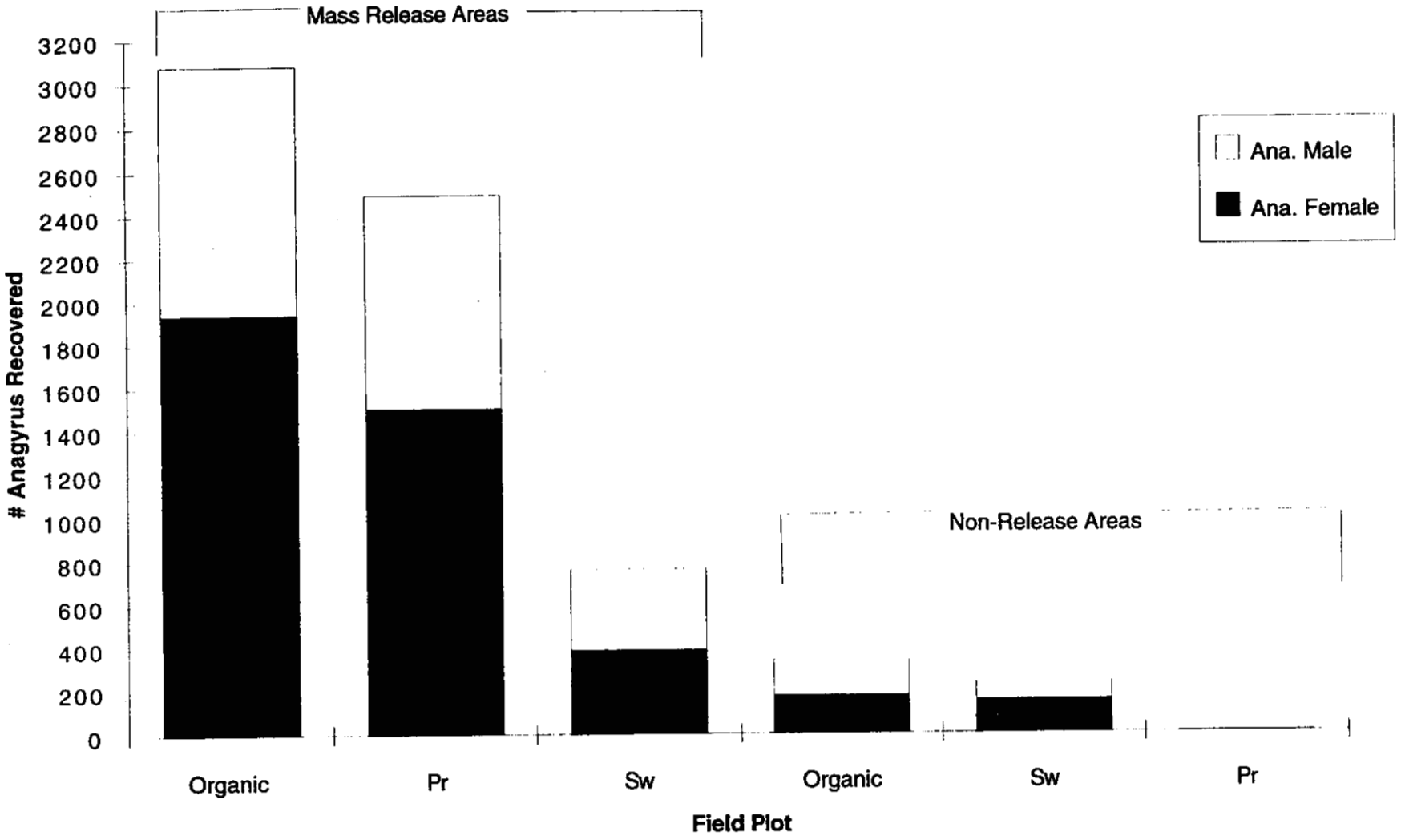


Figure 3

Parasites Recovered In Open Cage Trials 1997

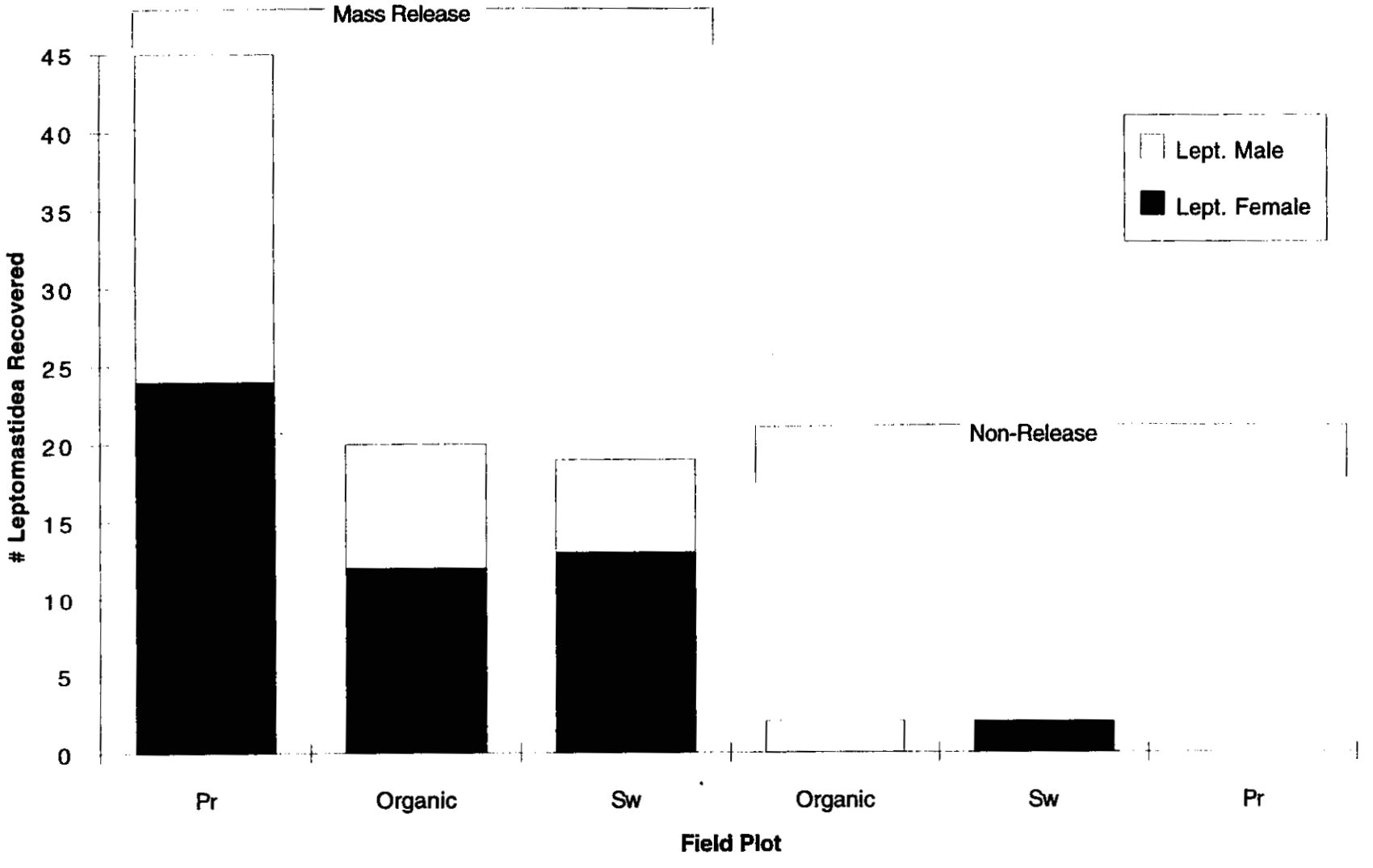
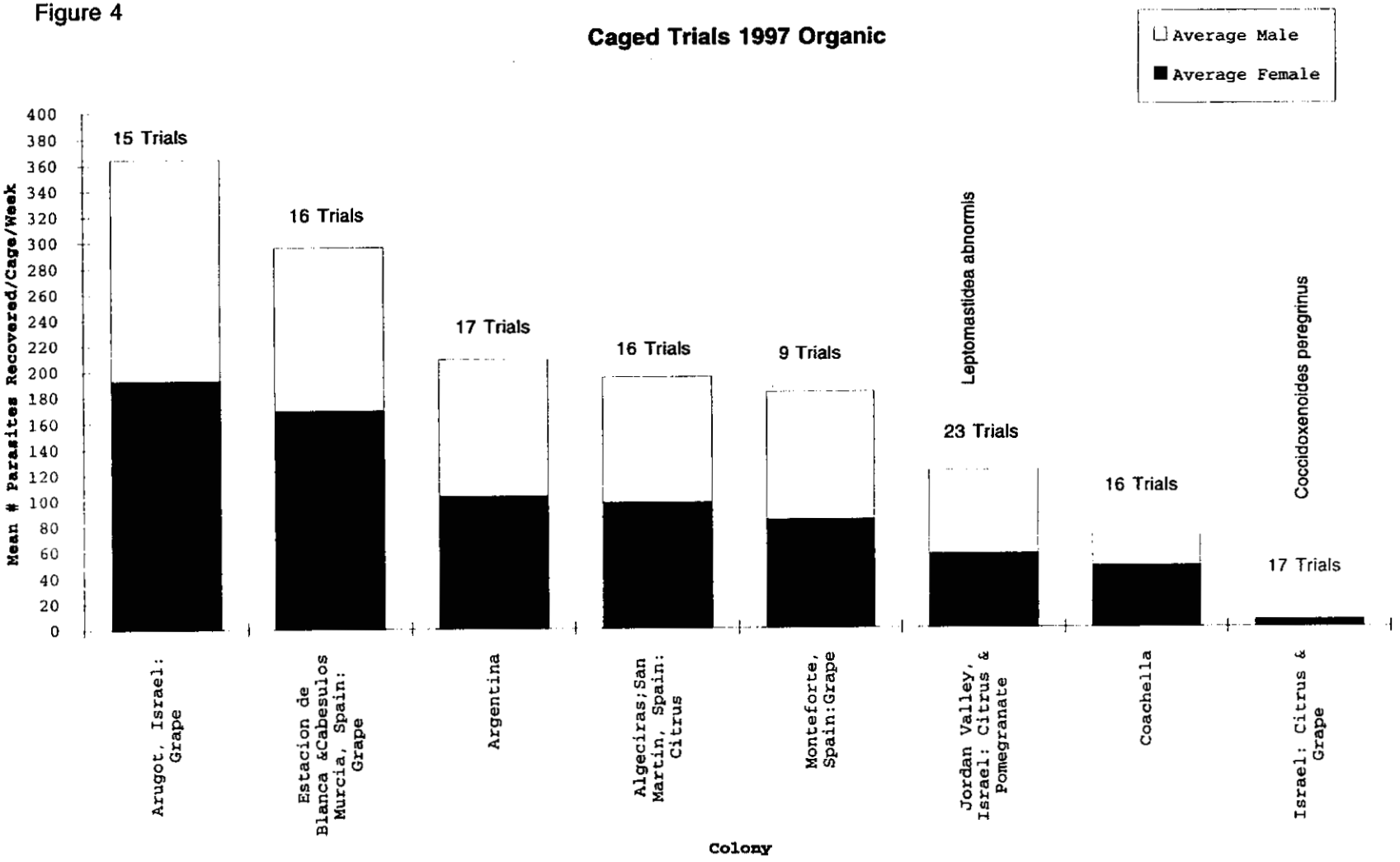
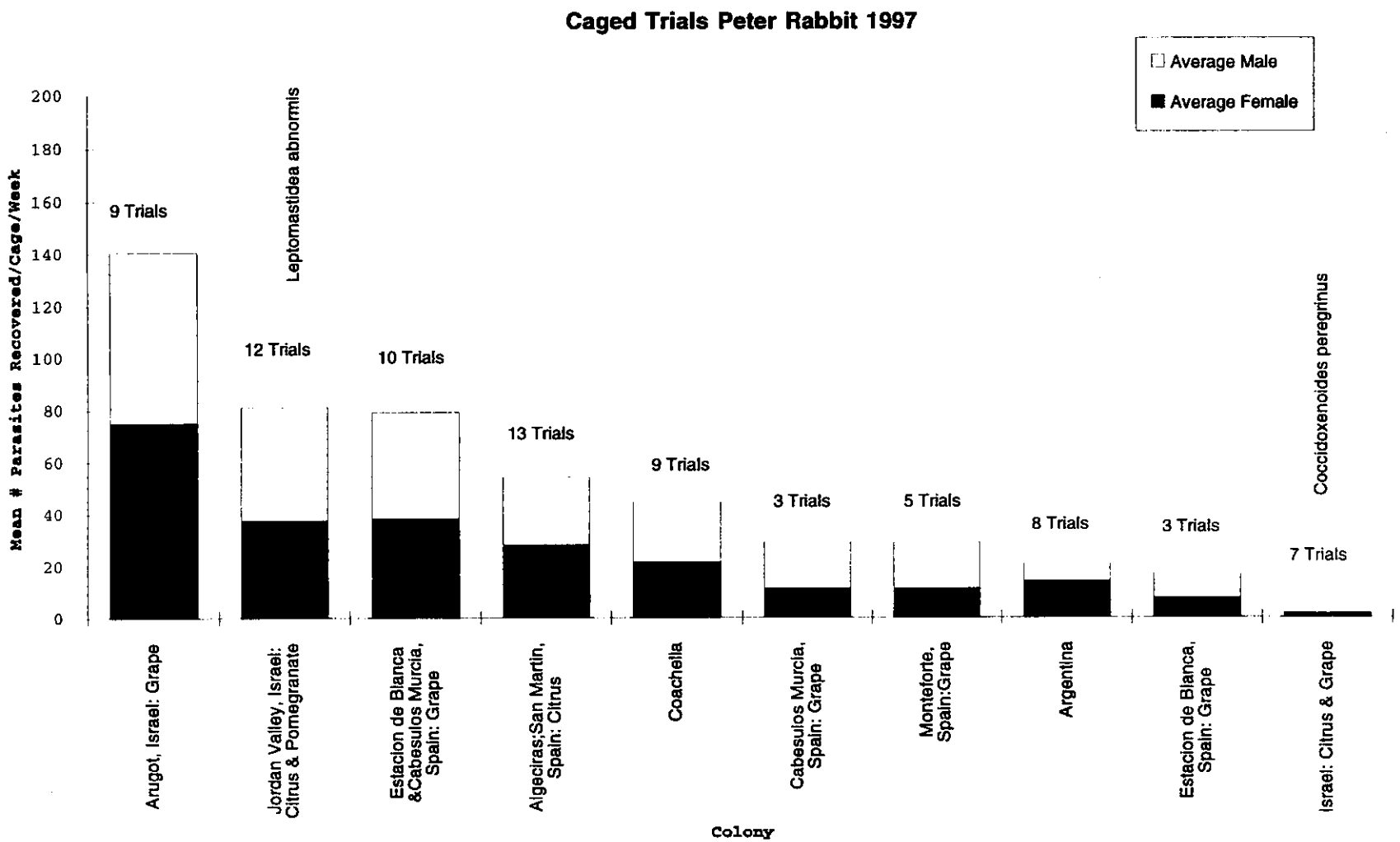


Figure 4



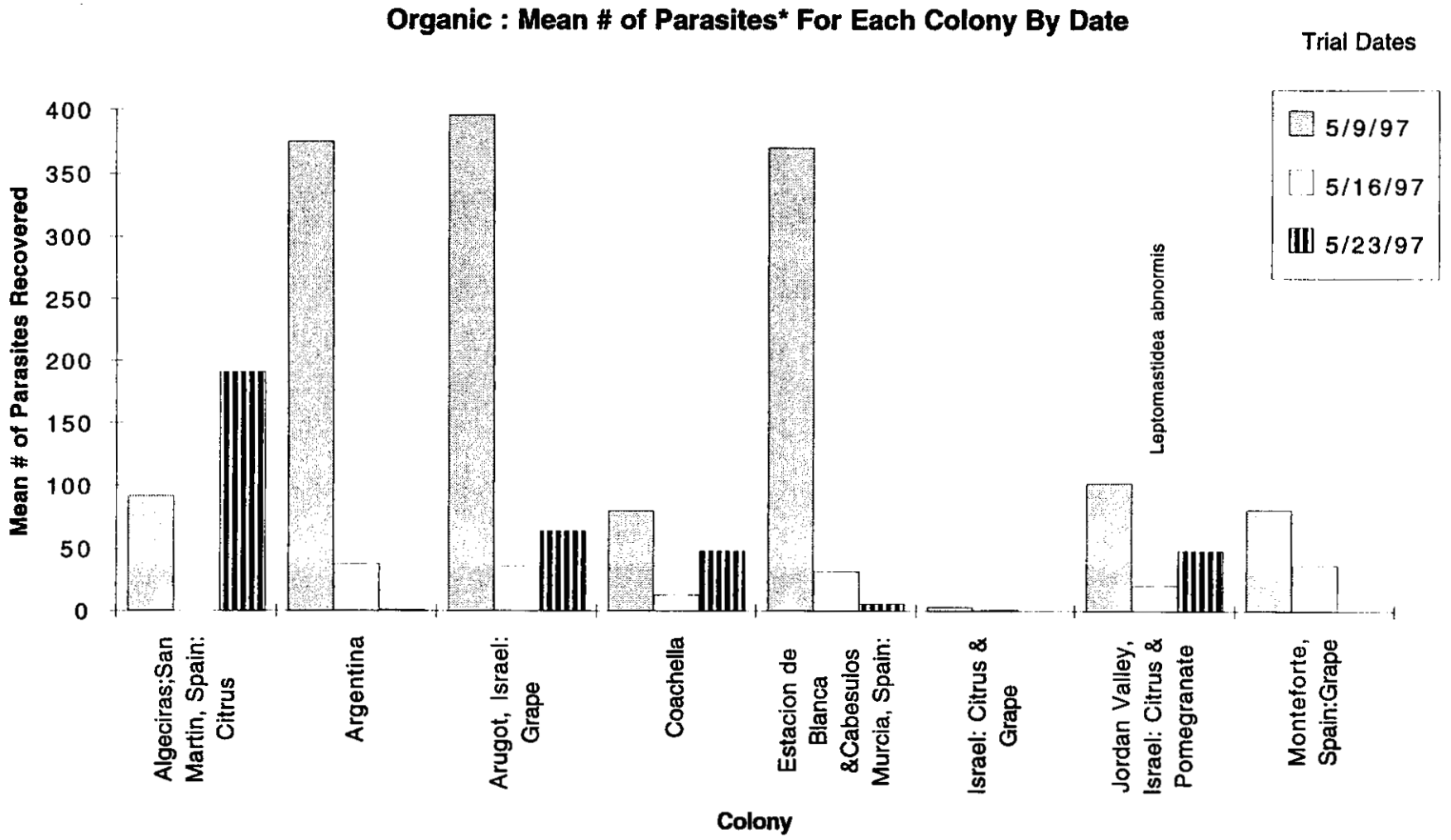
(Total Parasites Released 142,680)

Figure 5



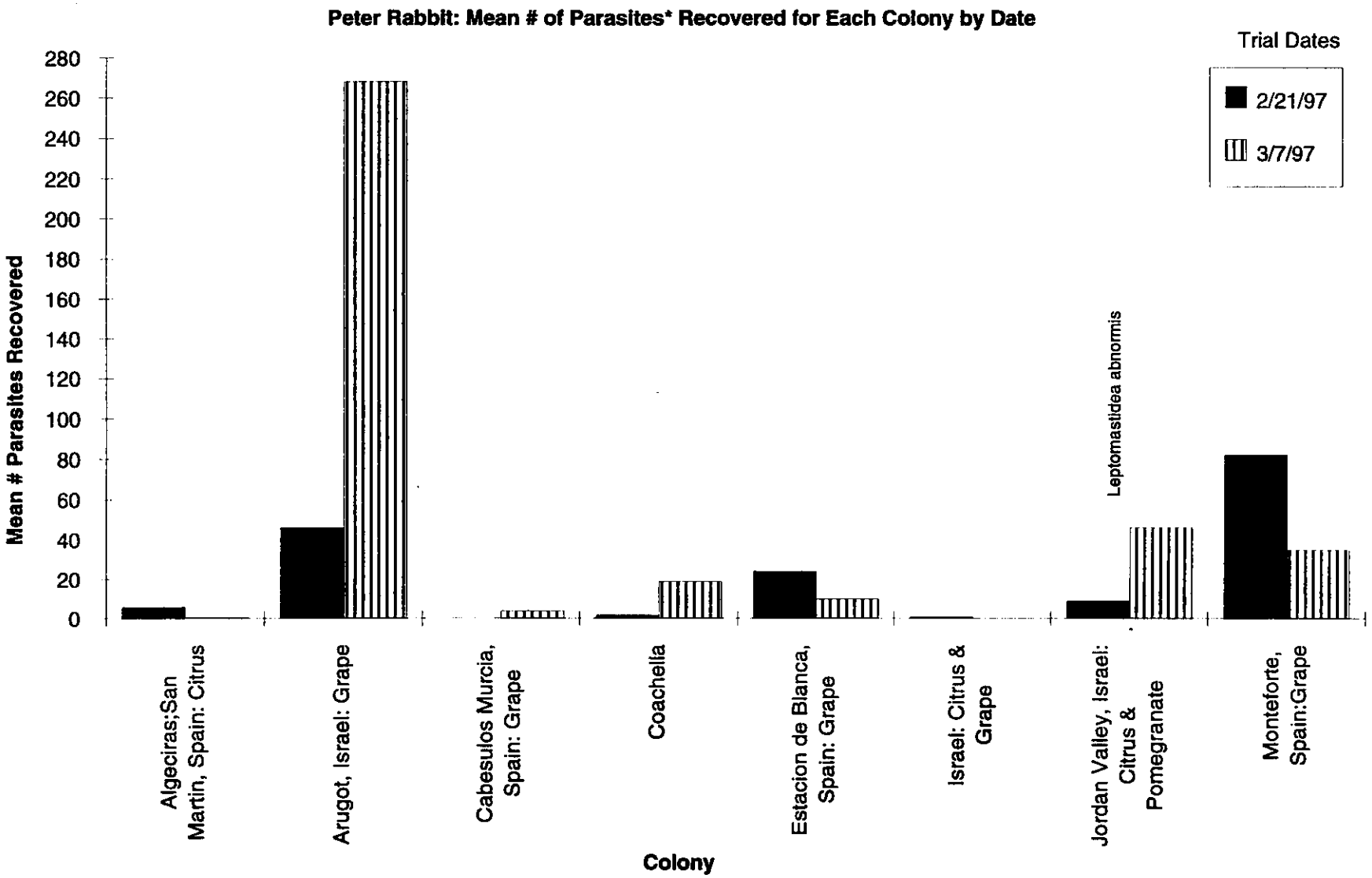
(Total Parasites Released 25,960)

Figure 6



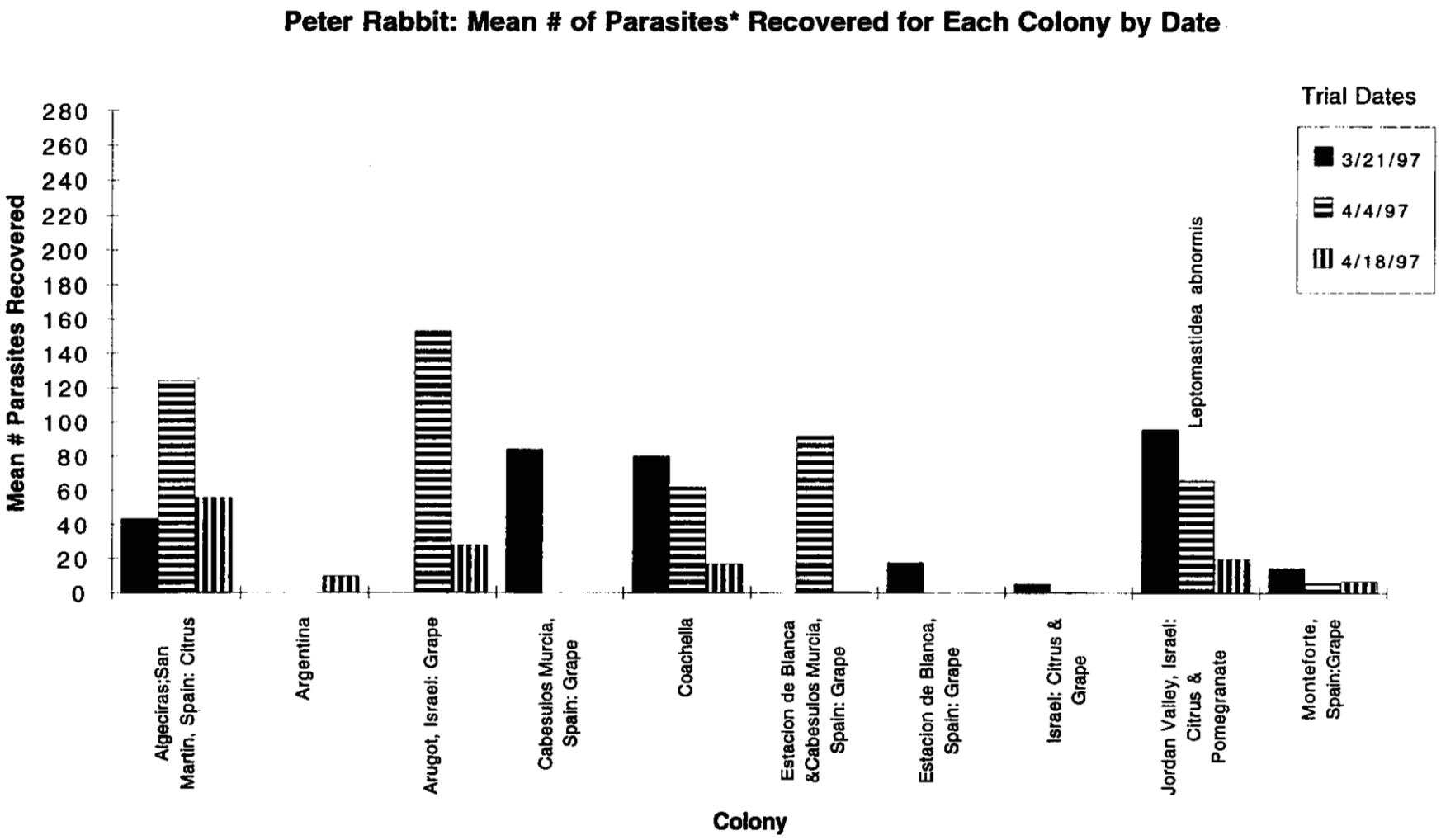
* Anagyrus parasites with exception noted.

Figure 7



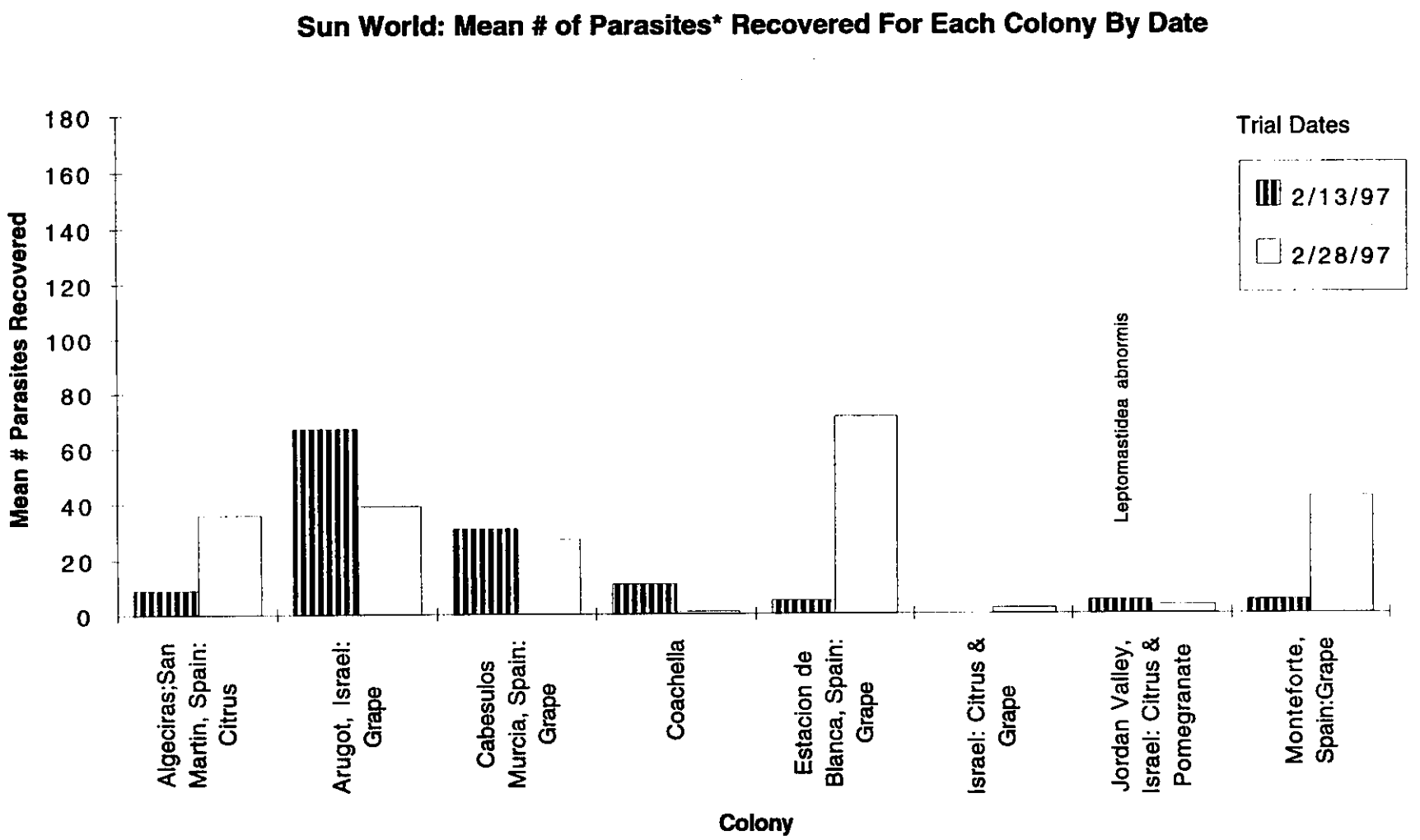
* Anagyrus parasites except where noted.

Figure 8



* Anagyrus parasites except where noted.

Figure 9



*Anagyrus parasites except where noted.